KEMP

Insurance Engineering And its Application to a Steel and Iron Plant

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INSURANCE ENGINEERING
AND
ITS APPLICATION TO A STEEL AND IRON PLANT

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IS APPROVED BY ME AS FULFILLING THIS PART OF THE REQUIREMENTS FOR THE DEGREE

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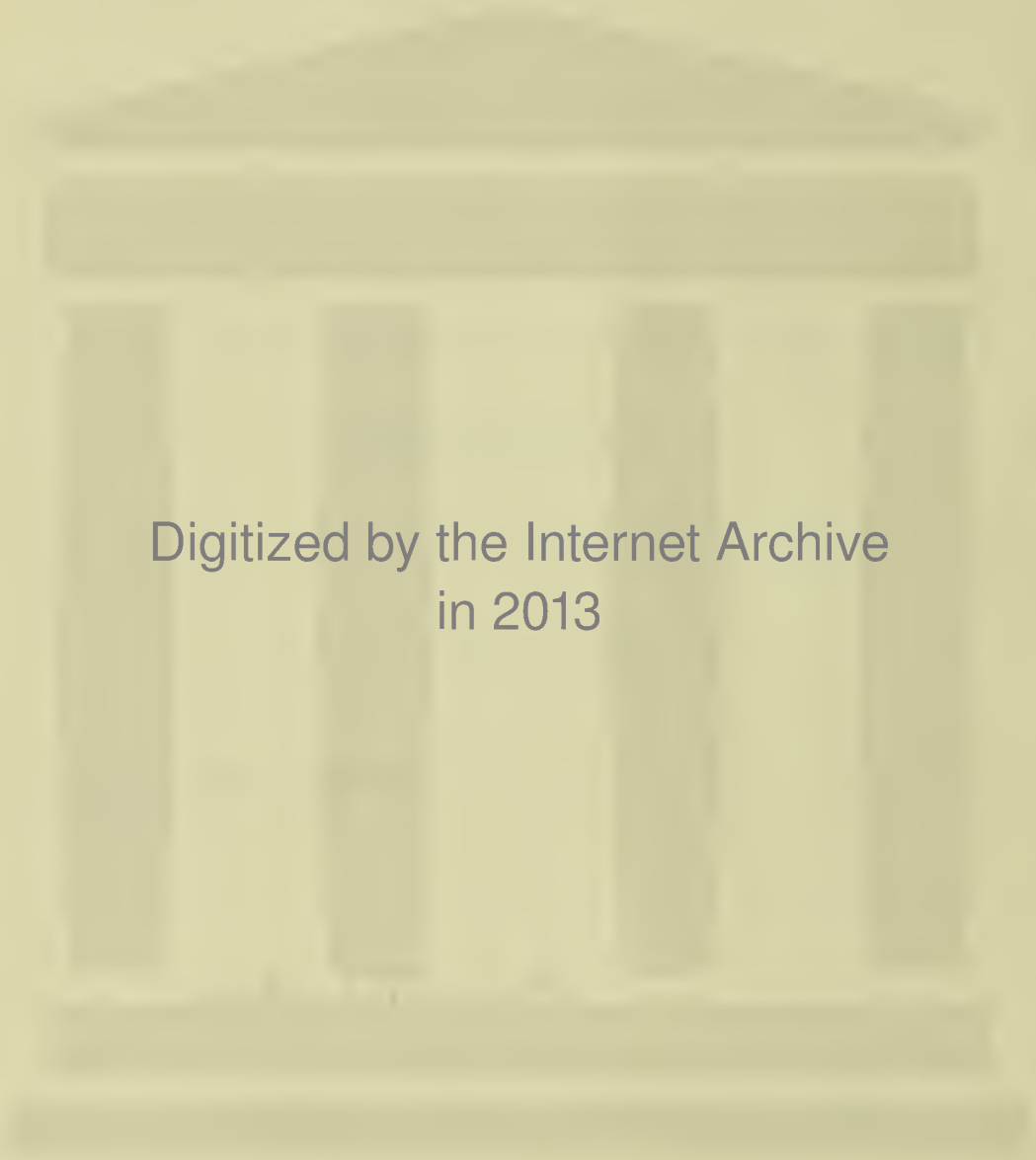

INSURANCE ENGINEERING AND ITS APPLICATION TO A STEEL AND IRON PLANT.

Insurance Engineering, or the science of fire protection, is daily growing in economic importance. The rapidly increasing amount of wealth invested in properties subject to destruction by fire makes the study of fire prevention an important duty, not alone of individuals and corporations, but of cities, states and nations. For too long a time in this country at least, we have been content to protect ourselves against individual loss by the payment of a certain percentage in insurance premiums without troubling ourselves to reduce the risk of fire through a safer system of construction and the installation of equipments that will give more adequate fire protection. Conditions are rapidly reaching the point where insurance companies must raise their rates, or go out of business, or educate the average property owner to the fact that it pays to build as fire-resisting a structure as the local conditions and dangers demand. Insurance companies and their trade papers are carrying on a campaign of education along these lines, and some of our largest industrial corporations are making a special study of this fire evil.

As a particular illustration of the economy of fire protection, the following table of allowances for wet sprinkler risks is given from the Boston Board of Fire Underwriters.

	Per Cent Reduction
(1) Wet pipe system with watchman and watch clock or with automatic fire alarm--	40
(2) Wet pipe system with watchman, watch clock and automatic fire alarm--	42-1/2

	Per Cent Reduction
(3) Wet pipe system with automatic fire alarm and electric notification system upon sprinkler system--	45
(4) Wet pipe system with watchman, electric watch clock and electric notification system--	45
(5) Wet pipe system with watchman, watch-clock connected with central station and approved electric notification system--	47-1/2
(6) Wet pipe system with automatic fire alarm watchman, electric watch-clock connected with central station and electric notification system--	50

In proof of their ability to make these allowances it should be said that they make a specialty of mill and factory risks and that their average loss ratio for the past ten years was 0.0382. It should also be said that during the year 1906, they carried $234,000,000.00 of insurance.

The National Fire Proctection Association has kept a very careful record of sprinkler fires since 1897, and the record for the past eleven years is given below:--

	TIMES REPORTED		PER CENT OF NO WITH DATA GIVEN	
	1907	1897-1907 Inclu.	1907	1897-1907 Inclu.
Practically or entirely extinguishing fire	594	3563	66.96	67.06
Held fire in check	240	1419	27.06	26.70
Total successful	834	4982	93.92	93.76
Unsatisfactory	53	331	5.98	6.23
	887	5313		

A further analysis of the unsatisfactory sprinkler fires shows

that 66% of these failures were due to the failure of the human element in the proper maintenance and manipulation of these systems. The above data is quoted to show what scientific fire protection may accomplish in the preservation of our national wealth. There is urgent need on the part of the public for general information and by our engineers and architects for a more special knowledge of the principles of fire protection.

The purpose of this thesis is to outline in a brief description the methods and means taken to protect the Western Tube Co., a United States Steel Corporation plant, at Kewanee, Ill. The writer has been in charge of the insurance engineering of that plant for the last three years, and the larger part of the fire protection system was designed and is being installed under his direction. In carrying out this work the suggestions of the National Fire Protection Association, of which the Western Tube Co. is a member, were followed as closely as possible. The United States Steel Corporation carries its own insurance through a special department organized for that purpose, and in a large part of the design the writer had the assistance of their insurance expert. A large percentage of this work yet remains to be done, but the policy of the company is to develop an adequate fire-protection system as rapidly as practicable.

The Western Tube Co. plant covers an area of approximately thirty acres. It includes among its departments, Brass, Malleable and Grey Iron Foundries. Scrap, Skelp, Pipe-Furnace, and Pipe Finishing Mills. Coupling, Nipple, Radiator, Galvanizing and Machine Shops, besides Stock, Boiler, Warehouse and other buildings When running full time, approximately 4000 people are given em-

MAP

OF

WESTERN TUBE CO. FIRE MAINS, HYDRANTS, VALVES, HOSE CONNECTIONS AND FIRE ALARMS

KEWANEE ILL — MAY-5-1908

Scale-1"=120' — R N

NOTE: Proposed extensions shown in black.

J E Kemp

N W E

KEY TO SYMBOLS	
	Water Mains 12 or 8
	" " 6
	" " 4 or 3"
	Smoke Stack
H	Hydrants
HRS	Hydrant Hoses &
	Nozzles
	Valves
HOSE	Hose Connections
FA	Fire Alarms

C. B. & Q. R. R. Right of Way

Site-12" New 240000 Gal Mains pipe

BOILER HOUSE No 1

BOILER HOUSE No 2

PRODUCERS

GAS HOUSE

ELECTRIC LIGHT PLANT

BRICK SHED

BLACKSMITH SHOP

MACHINE SHOP

PAINT SHOP

BOILER TIN SHOP

BOILERS

SCRAP SHED

SCRAP MILL

BUTT MILL WELDING

SHELP MILL

LATHE ROOM

OFFICE

SHED

SMOKE STACK

BRASS AND FITTINGS BLDG

FITTINGS STOCK HOUSE

STOCK HOUSE

BRASS CORE ROOM

FOUNDRY

FURNACE ROOM

BRASS

COOPER SHOP

MALLEABLE ANNEALING

ENGINE ROOM

BOILER HOUSE #3

MALLEABLE IRON FOUNDRY

NEW MALL. ANNEALING

MALL CORE ROOM

SAND HOUSE

SAND SHEDS

SAND SHED

SAND MIXING ROOM

SOCKET BENDING & WELDING

BUTT MILL FINISHING

NIPPLE BURR & FLOOR

PIPE STORAGE

BRASS SCRAP STORAGE

PIPE SHED

GALVANIZING SHOP

GALVANIZING MACH.

CISTERN

BLANK STOCK

G. I. CORE ROOM 2nd FLOOR

SCRATCH ROOM

GREY IRON FOUNDRY

MENS CORE ROOM

MAIN OFFICE

SAND HOUSE

BOILER HOUSE #4

ENGINE ROOM

CORE ROOM

SCRAP SHED

CUPOLA ROOM

SAND SHEDS

BARN

WAGON SHED

W. T. Co.

ALLEY

BURNT ST.

ELM ST.

WALNUT ST.

6" CITY MAIN

C. & S. Rail Yard Cross Tracks

Class No. 340

Dwg. No 656

ployment. These buildings offer a variety of conditions ranging from the mill buildings containing practically no inflammable material, to the all timber, four-story stock-house. The four-story stock buildings and machine shop are considered the extreme hazard as upwards of two million dollars worth of machinery and stock are carried in these buildings. These varying conditions makethis plant an interesting problem in insurance engineering.

Attached hereto is a small map, showing the location of buildings, fire mains, valves, hydrants, fire alarm boxes and showing in black the proposed extensions to the mains. (See page 4) It should be noted that all buildings, hydrants, valves and alarms are numbered. This is for the benefit of the fire, water and watchman departments whose members are each supplied with copies of this map. The purpose of this map, which is brought up to date each year, is to keep these men thoroughly familiar with the details of the fire protection system.

BUILDING CONSTRUCTION

The starting-point of insurance engineering is the construction of the building. Past experience has taught valuable lessons which, if heeded, mean decreased fire risks. Walls must be amply strong, free from unguarded openings, and carried well above the roof line. Columns, joists, girders, floors and roof construction, if of wood, should be of the type known as "slowburning", that is, of such depth and thickness that they are not readily destroyed by a quick, sharp fire. No concealed spaces should be allowed, and elevators and stairways must be shut off within brick-walls. All doorways, traps, etc., must be equipped with lock-jointed,

tin-covered doors, closing automatically in case of fire. If elevators pass through floor-openings, these should be closed by means of doors which are opened and shut by the passage of the elevator, otherwise automatic gravity fire doors should be provided. Window exposures should be protected by iron shutters, wire glass sash in steel frames or open sprinkler systems. All buildings of two or more stories should have adequate fire escapes, which with all other exits and fire apparatus should be marked with red lights. These rules constitute a brief resume of the Western Tube Company's efforts along the line of fire prevention in their building construction.

One of the buildings, soon to be erected, the pattern storage ware house, has some novel features from an insurance standpoint. The thoroughly-seasoned, painted wood of the patterns makes an expensive risk and a special effort was made to make this building as fire-proof as possible. It will be a nine-room, three-story steel building with reinforced-concrete walls, floors and roof. Each room is 35'x48', without windows and with but one door which opens out onto a steel and corrugated iron passage-way to elevator on the outside of the building. Each piece of structural steel has a minimum fire proofing of two inches of concrete. The concrete roof is to be covered according to the Barrett specification, and has concrete parapet walls 12 inches high built so that the paper is laid out to the edge of the walls. This does away with all flashing as drainage of roof is to center-line of building. Sufficient ventilation to keep the air pure is provided by three vertical lines of 12-inch sewer pipe with 9-inch openings into each room. These openings are guarded by flap-valves held open by

wires inter-connected by fusible links to other wires connecting with flap-valves on ventilator castings set at the floor level in the side walls. These castings also act as scuppers as the floors are pitched from center to sides. Patterns will be stored on angle iron racks shelved with sheet metal to check flames from shelf to shelf. Each room has its own system of electric lights and switch board and at the side of the entrance is installed a line of 1-1/2 inch hose on a specially designed quick action hose-rack. A system of thermostats connected to the central watchman's house completes the equipment. On account of the risk by water damage, no sprinkler system was put in, but the intention of the design is to check a fire through lack of air until the thermostat rings in the alarm. This building, when complete, will be the best protected building in the Western Tube Company's plant, and one of the most fire-proof pattern storage buildings in the United States.

WATER SUPPLY

The primary water supply is derived from three artesian wells driven into the St Peter sandstone, approximately 1500 feet deep. These wells have a combined daily capacity of more than 540,000 gallons of water, which is raised by means of air at 120 pounds pressure from two Norwalk straight line compressors. The discharge pipes from the wells lead into small underground reservoirs, from which the water is pumped into a 100,000 gallon tank, twenty feet above ground level. This tank feeds a gravity cold water supply main from which water is used for manufacturing purposes and with a 20,000 gallon steel tank immediately below. From this steel tank a 12 inch suction main connects with a 1000 gallon Underwriters'

steam fire pump, on which there is always a steam pressure of 80 pounds. The water level in this larger storage tank is never allowed to drop more than four feet from the top and any dangerous draught of water is compensated by the curtailment of its use in the manufacturing departments, even to the complete shut down of the factory use of water in case of fire. This allows for immediate use, for fire purposes, 95,000 gallons of water, which will supply four 250-gallon-per-minute fire streams (the capacity of the pump) for one hour and thirty five minutes. But by running the wells to their full capacity we can deliver 375 gallon per minute into this tank, thereby creating a supply which will run the fire pump to its full capacity for two hours and fifty five minutes. This supply is considered inadequate for the needs of this plant in case of a severe fire, and our fire protection improvement scheme calls for the installation of a duplicate fire pump, the sinking of an 8 inch well into the Trenton rock, and the construction of a 200,000 gallon steel storage reservoir. This extension will allow eight effective fire streams when necessary and give adequate opportunity for pump repairs without lowering the pressure of 45 pounds which is the nominal pressure maintained in the fire system. We can safely figure on 150,000 gallon per day additional supply from this new well which will in case of extreme need, give the fire department the use of eight effective fire streams for three hours and ten minutes. This primary system is our main reliance.

Steam for use in the fire pump is taken off the large supply main leading from No. 1 Boiler House which contains four batteries of four 200 H.P. boilers each. The 7000 B.H.P. of the plant is

so inter-connected that a uniform pressure of 80 pounds is maintained over the entire plant.

A brief study of the accompanying map, (See page #4), will show how inadequate our present system of supply mains is. An 8 inch main leads from the pump branching into three circuits of 6 inch mains on which all the hydrants, hose connections and sprinkler systems are located. Each valve is enclosed in a brick catch-basin with a cast iron cover and numbered on the map. The measured location of each valve is shown in a list which is given to all workmen who have any need ofit in their work. The black lines on this map show the redesign of this supply system. One line of 12 inch main is to extend to the west end and two lines to the east end cross-connecting with and back feeding the smaller mains of the old system wherever possible. This new main is to be laid with extra heavy kalomeined steel pipe with congress-joints. This pipe will be carefully tested before any back filling is done and then covered with six inches of tamped yellow clay to prevent corrosive action of the cinders. The valves on this main will be covered and numbered the same as in the old system.

The hydrants in use are the double nozzle, Ludlow hydrant threaded to the same standard as that used by the City of Kewanee. In places of greatest fire hazard these hydrants are specially equipped as described later.

All buildings where any special danger from fire exists are equipped with 4 or 6 inch risers to which are connected lines of 2-5/8 inch hose varying in length from 50 feet to 150 feet. These lines are attached to valves, coiled on specially designed racks and equipped with Underwriters standard 1-1/8 inch play pipe.

These hose connections are located at intervals of not more than 150 feet and their presence ready for instant service at all times has proved one of the best means for the control of incipient fires.

Of the four types of sprinkler systems, the wet and steam sprinkler systems are the only ones in service at present. In the Stock-houses, aggregating 180,000 square feet of floor space, wet sprinkler systems have been installed, and the water pressure is at all times kept above 25 pounds on the highest sprinkler head. Pressure gauges give at all times a check on this pressure and rising stem valves are used to prevent the possibility of their being left closed. In the Japanning Building and Oil House, steam sprinkler systems are used because of the greater efficiency of steam in choking an oil fire. In this system the sprinkler heads are the same as in the wet system, but the steam riser is carried to the highest point of the room and then dropped twelve inches and the horizontal piping run in the usual way. Water is then introduced into this horizontal piping until it overflows into the steam pipe and this water protects the heads when steam is turned on. As yet we have had no trial of this steam system, but it has given excellent results in other plants.

One of our especially dangerous hazards is the window exposure in the three four-story buildings which form an ell-shaped alley, but ten feet wide. After a comparison of iron shutters, wire glass windows and open sprinkler systems, the last named method was chosen as the most satisfactory solution of this problem. Our plans include a series of open sprinkler systems covering the windows on the exposed faces of these buildings and connected to

a ten inch supply main through valves at the base of each riser. In case of fire in one of these buildings, water will be turned into those systems covering the exposed windows.

As all sprinklered buildings are heated in cold weather, there has been no need for the installation of any dry systems.

As a secondary supply for our fire systems there are four six-inch connections with the mains of the Kewanee City Fire Department. These connections are controlled by post indicator valves as shown on the map, (See page #4). The city water supply is drawn from deep wells similar to those of the Western Tube Co., but the reservoir capacity is 1,500,000 gallons. Under existing arrangements, in case of a Western Tube Co. fire alarm, pressure is at once turned on by the city water department and maintained until ordered off by the City Fire Chief.

FIRE DEPARTMENT

The Western Tube Co. Fire Department is a volunteer organization composed of 25 men divided among one night and two day companies. Each company is in charge of a Captain and the three companies are under the immediate command of a Fire Chief who reports in writing to the General Superintendent. The members, chosen from various departments, are men strong, active, intelligent and able to think for themselves. The Fire Chief, a machinist, is a member of the City Volunteer Company and has had a number of years experience in this kind of work.

Each Saturday afternoon an alarm is rung in and a practice drill held. Different points are chosen each week and the men are practiced in breaking and coupling the hose, scaling walls and

handling the hose under pressure. No one but the chief knows from what point the alarm will come in and both companies report to that box from which the alarm is sent in. They are there informed the exact location of the fire and all available hose connections are trained "on the fire". The time from the turning in of the alarm till the hose leads are trained on the spot is taken and recorded as part of the report.

Each member reporting for drill is allowed $.50, the captains $1.00 and the chief $1.50. In case of a day fire the men at work receive their usual wages but at night fires they are paid $1.00 for the first hour and $.50 per hour thereafter. In times of shutdown or when the night turns are off, a paid company is put on, whose membership is made up of men from the fire department.

Each fireman has his book of instructions giving number and location of every alarm station, hydrant, hydrant house and water main valve. Lists of alarm stations and Fire Protection maps are posted in various places throughout the works, and every effort is made to acquaint the men with the details of the system.

There is no special salvage crew as the buildings differ so widely in character that the best results can be obtained by making each foreman responsible for the management of the salvage work in his department. In case of the absence of the foreman, this work is done under the direction of the Fire Chief.

The two hose-cart houses, one in each end of the plant, are equipped with carts carrying 400 feet of 2-5/8 inch hose on reels. Attached to the free end of the hose is a Callahan relief valve and fastened on the carts are a 1-1/8 inch Callahan flexible shut-off nozzle, a 3/4 inch Anderson shutt-off and spray nozzle and the

usual Underwriter's standard play pipe. In addition, the carts carry ropes, lanterns and the usual complement of tools. These houses are each equipped with a Gamewell Annunciator gong and indicator showing the number of the box from which the alarm is turned in. These houses are steam-heated and are made the headquarters of the paid department when on duty.

Twelve of the hydrants controllingimportant risks are covered by houses, electric lighted and equipped with the following tools:- lanterns, wrenches, spanners, hose-straps, bars, axes and extra couplings. Back of the hydrant are two shelves, the upper one containing one or two lengths of unattached hose, while the lower one has coiled upon it two or three lengths with play pipe attached and connected directly with the hydrant nozzle. The other nozzle is equipped with a hose valve thus allowing the use of the second nozzle without interference with the first. The hose used throughout the plant is an approved brand of 2-5/8 inch rubber-lined cotton hose. The only exception is the solid rubber hose used in the Galvanizing Department on account of its greater durability. In the new Pattern Storage Building, fifty foot lengths of 1-1/2 inch unlined cotton hose will be installed

In buildings where oil is used, pails of dry, spent, molding sand are hung on the walls and columns; and in buildings where there are corners difficult of access to hose streams, hand grenades, chemical fire extinguishers and water barrels are provided. Hung up on the outside walls of buildings around the plant are six 20-foot and two 35-foot ladders. All buildings whose roofs are inaccessible to a 30 foot ladder are provided with permanent iron ladders and fire escape platforms. For the care and maintenance

of the hose, a hose-drying tower has been built in connection with Hose Cart House No. 2. This building is provided with tub and drying rack, and a set of reels in the 30 foot roof over which 50 foot lengths can be hung to drain and dry. A bench with hose expander, tools and supplies complete its equipment. This is the headquarters of the hose inspector and all spare hose is kept hung on these racks.

The above description includes only the principal apparatus but it is sufficient to show what can be done in the way of fire department organization and equipment in a plant of this size.

FIRE ALARM STATIONS

Fire alarms can be rung in from thirteen Gamewell fire alarm boxes, located at points easy of access from the most important risks. These boxes are in all cases placed in conspicuous positions and each equipped with a red incandescent light and a sign warning every one to keep the space in front of the box free from obstructions. These boxes are cut in on a circuit which includes indicator gongs in No. 1 and No. 2 Hose Cart Houses, the City Fire Department and the Electric Light and Power Plant. This circuit also includes whistles in the Pump House and No. 3 Boiler-house and gongs in the Pump House, the Compressor Building and No. 1 Boiler House. Electricity for this circuit is supplied from two sets of storage batteries located in the Light and Power House, one battery being used while the other is being charged. A complete test of every box and indicator, etc., is made every two weeks, one-half the boxes being tested each week while the fire drill is going on. During this test, men from the Electrical

Department are stationed at each whistle and indicator to note its action as the alarm is turned infrom one box after another, and to restore the indicator and whistle drops after each alarm. Since the installation of the first alarm box two years ago, this electrical apparatus has been maintained in such order that it has given perfect service.

Sprinkler alarm valves for all sprinkler risers are soon to be installed. This means that an automatic, electric, alarm valve at the base of each sprinkler riser will be connected by an electric circuit to indicator gong in Central Watchman's House in such a way that the opening of a sprinkler head will ring in an alarm indicating the location of the flowing water. The purpose of this system is two fold: first to give the fire alarm and secondly to protect stock from water damage in case of accident to sprinkler head. This precaution is to be taken in addition to the regular watchman service.

In the proposed Pattern Storage Building the several rooms will be equipped with thermostats connected by electric circuit to indicator in central watchman's house. These thermostats are relied on to give the alarm of fire in these pattern storage rooms which will not be covered by the watchman service. This central watchman's house and the Electric Light and Power house have connections with the public telephone independent of the plant system and in case of fire alarm, the General Superintendent, Insurance Engineer, Fire Chief, Pump Foreman, and Hose Inspector are notified at once. This system of electrical alarms is a powerful factor in reducing the number of minutes elapsing between the origin of a fire and the arrival of the Fire Departments.

INSPECTION & MAINTENANCE

Success in fire control is generally a matter of minutes, occasionally of seconds and the prime requisite of any fire department apparatus isthat it shall be at all times ready for instant and effective use. In this plant a double system of inspection insures effective readiness throughout the department. A force of 21 watchmen are employed as follows: 20 men alternate night and day turns; 8 at the entrances to the plant and 12 in patrolling the yards. Whenever the paid night fire department is on duty, each watchman is accompanied by a fireman. At twelve points chosen as the most dangerous on each of these six circuits through the plant are located keys that register their hourly inspection in clocks carried by the watchmen. These clock records are then turned in each morning with special reports of any unusual occurences or suggestions resulting from the inspections of the preceding twenty-four hours. These inspections cover the following items, important from a fire protection standpoint: Condition of fire apparatus, cleanliness of the various departments and dangerous conditions in buildings, yards and appliances.

The duty of a watchman in case of fire is to turn in the alarm at the nearest station (unless he is certain he can control the fire single-handed with the local apparatus) and then use his best judgment in fighting the fire until the arrival of the Fire Departments. On their arrival he is expected to assist by keeping onlookers and those not engaged in salvage work, out of the way and out of danger. The gate watchmen in case of fire admit the City Department and employes of the company, but all others are kept out for the sake of their own safety. The watchmen are

provided with maps of the fire system of the plant and are required to post themselves on these points so that when necessary they can do the work of the Fire Department.

The second inspection is made by the Hose Inspector, who is that member of the Fire Department that gives his whole time to the care of the apparatus. This inspection is made every morning (except Sunday) between the hours of 7:00 and 9:00 A. M. and his personal report is then made to the Insurance Engineer. Preceding this report each morning the complaints and suggestions regarding the Fire Department by watchmen have been sent in by the General Superintendent and these are taken up with the Inspector. His daily inspection includes all fire apparatus and buildings, and his duties include the entire care of all excepting the electrical fire apparatus. Twice each month, the 7000 odd feet of fire hose is taken out, brushed and relaid. Once each month, all hydrants and couplings are inspected and oiled and twice each year, all valves are inspected and tested. He is also required to look after the cleanliness of all tar and gravel roofs and to report any unusual conditions noted in the buildings. He is especially held responsible for the proper manipulation of all valves in case of fire and sees to the drying and replacing of all hose used. His work in conjunction with the "competitive" inspection of the watchmen insures the highest degree of preparedness that has yet been attained in the Western Tube Company's Fire Department.

This fire protection system has been instrumental in securing a steadily increasing reduction in the Western Tube Co.'s insurance rates as the above described improvements have been made from year

to year. In building construction the effort has been to install in the existing structures every safe-guard economically practicable, and in design and construction to make new buildings as fire resisting as possible. In the extension of the water-supply, the aim has been to secure an adequate amount in constant readiness at all points in the plant. The organization and the equipment of the fire department have been planned to provide men and apparatus for effective fire-fighting at every place within the grounds in the shortest possible time after the discovery of fire. The alarm systems are being installed to insure the earliest discovery and the quickest spread of the alarm of fire. The inspection and the maintenance of the fire-fighting system and the buildings and the grounds, are most carefully watched to insure their, effectiveness in keeping all apparatus in the best shape and the buildings and the grounds free from conditions tending in any way to increase the fire risk. In short, in this plant, the aim is first to make fires impossible, and second to provide every available means for their prompt extinction. In these two problems are summed up the essentials of the science of fire protection.